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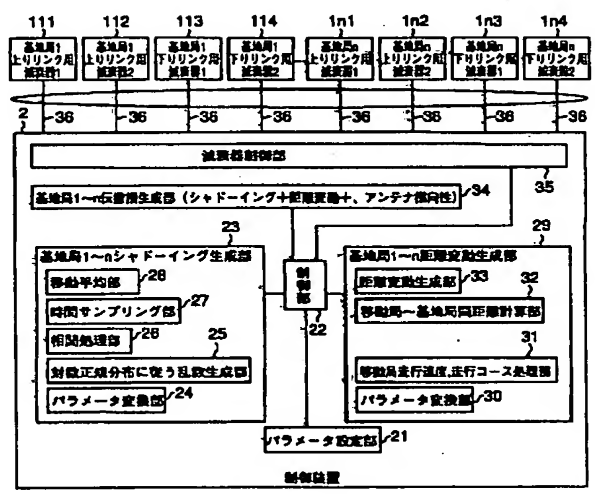
(54)【発明の名称】 マルチセル伝搬環境模擬装置

(57)【要約】

【課題】 移動局が移動している場合にも特性の評価を行えるように、シャドーイング及び距離減衰を模擬するマルチセル伝搬環境模擬装置を提供する。

【解決手段】 複数の減衰器と、該減衰器の減衰量を制御する制御装置とを有しており、該制御装置は、１台の移動局及び複数の基地局の仮想的な位置及び各基地局のセクタアンテナの指向パターンを予め設定し、移動局と基地局との間の複数伝搬路の伝搬損を疑似するように減衰器の減衰量を制御するように構成されているマルチセル伝搬環境模擬装置である。また、フェージングシミュレータを制御することにより、瞬時変動、距離減衰及びシャドーイングの全ての模擬を可能とする。



【特許請求の範囲】

【請求項１】　複数の減衰器と、該減衰器の減衰量を制御する制御装置とを有しており、該制御装置は、１台の移動局及び複数の基地局の仮想的な位置及び各基地局のセクタアンテナの指向パターンを予め設定し、移動局及び基地局の間の複数伝搬路の伝搬損を疑似するように減衰器の減衰量を制御することを特徴とするマルチセル伝搬環境模擬装置。

【請求項２】　前記伝搬損は、距離減衰及び／又はシャドーイングであることを特徴とする請求項１に記載の装置。

【請求項３】　前記制御装置は、前記移動局の仮想的な移動経路及び移動速度を予め設定し、前記移動局の移動に応じて伝搬損を変化させることを特徴とする請求項１又は２に記載の装置。

【請求項４】　パラメータとして標準偏差及び平均値を用いて対数正規分布に従う乱数を、平均ビル幅及び移動局移動速度から求まる平均周期毎に、複数基地局間の相関を含めて生成し、該乱数の移動平均を前記基地局毎の前記シャドーイングとすることを特徴とする請求項２又は３に記載の装置。

【請求項５】　前記制御装置は、設定されている基地局位置及び各基地局のセクタアンテナの指向パターン、伝搬路パラメータ並びに移動局移動経路及び移動速度をもとに、時間の経過と共に前記移動局を仮想的に移動させて、該移動局の移動に伴って変化する前記伝搬損を計算し、該伝搬損に従って逐次外部の複数の減衰器を制御することを特徴とする請求項３又は４に記載の装置。

【請求項６】　前記制御装置は、移動局送信及び基地局受信の上りリンクと、基地局送信及び移動局受信の下りリンクとを別々に制御することを特徴とする請求項２から５のいずれか１項に記載の装置。

【請求項７】　前記制御装置は、前記基地局毎に、前記シャドーイングの変化のタイミングをランダムに変えることを特徴とする請求項３から６のいずれか１項に記載の装置。

【請求項８】　前記制御装置は、前記距離減衰を一定のまま、前記シャドーイングを変化させることを特徴とする請求項２から７のいずれか１項に記載の装置。

【請求項９】　フェージングシミュレータを組み合わせて、前記制御装置が該フェージングシミュレータも制御することを特徴とする請求項２から８のいずれか１項に記載の装置。

【請求項１０】　前記制御装置は、前記移動局の移動速度の変化に応じてフェージングを変化させることを特徴とする請求項９に記載の装置。

【請求項１１】　前記減衰器が、ＰＩＮダイオード連続可変減衰器であることを特徴とする請求項１から１０のいずれか１項に記載の装置。

【請求項１２】　前記制御装置は、伝搬路のパラメータ並びに移動局の移動経路及び移動速度を外部から設定できることを特徴とする請求項３から１１のいずれか１項に記載の装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、陸上移動通信の無線伝搬環境を簡易に模擬するための、伝搬環境模擬装置に関する。

【０００２】

【従来の技術】陸上移動通信の無線伝搬損は、(a)瞬時変動、(b)シャドーイングによる短区間中央値変動及び(c)距離減衰の３種類の特性が重畳した結果として考えられている（進士昌明著「移動通信」Ｐ．５５、丸善(株)刊）。従来、伝搬環境模擬装置は、無線伝搬の基本特性を測定するために作られており、瞬時変動のみを模擬対象としている。

【０００３】

【発明が解決しようとする課題】しかし、フェージングシミュレータは、シャドーイング及び距離減衰を模擬できないため、移動局が移動している場合に、ハンドオーバ（移動局の移動に伴って、基地局を切り替える動作）等の応用特性の動作・性能の評価を行えなかった。

【０００４】そこで、本発明は、移動局が移動している場合にも特性の評価を行えるように、シャドーイング及び距離減衰を模擬するマルチセル伝搬環境模擬装置を提供する。

【０００５】

【課題を解決するための手段】従って、本発明によるマルチセル伝搬環境模擬装置は、複数の減衰器と、該減衰器の減衰量を制御する制御装置とを有しており、該制御装置は、１台の移動局及び複数の基地局の仮想的な位置及び各基地局のセクタアンテナの指向パターンを予め設定し、移動局と基地局との間の複数伝搬路の伝搬損を疑似するように減衰器の減衰量を制御する。これにより、複数基地局（マルチセル及びマルチセクタセル）環境下での移動局の動作・性能を評価できる。

【０００６】本発明の他の実施形態によれば、伝搬損は、距離減衰及び／又はシャドーイングである。

【０００７】本発明の他の実施形態によれば、制御装置は、移動局の仮想的な移動経路及び移動速度を予め設定し、移動局の移動に応じて伝搬損を変化させる。これにより、移動局の移動パターンの影響を評価できる。

【０００８】本発明の他の実施形態によれば、パラメータとして標準偏差及び平均値を用いて対数正規分布に従う乱数を、平均ビル幅及び移動局移動速度から求まる平均周期毎に、複数基地局間の相関を含めて生成し、該乱数の移動平均を基地局毎のシャドーイングとする。

【０００９】本発明の他の実施形態によれば、制御装置は、設定されている基地局位置及び各基地局のセクタアンテナの指向パターン、伝搬路パラメータ並びに移動局

移動経路及び移動速度をもとに、時間の経過と共に前記移動局を仮想的に移動させて、該移動局の移動に伴って変化する前記伝搬損を計算し、該伝搬損に従って逐次外部の複数の減衰器を制御する。

【００１０】本発明の他の実施形態によれば、制御装置は、移動局送信及び基地局受信の上りリンクと、基地局送信及び移動局受信の下りリンクとを別々に制御する。これにより、上りリンクと下りリンクの伝搬特性の違いを反映できる。

【００１１】本発明の他の実施形態によれば、制御装置は、基地局毎に、シャドーイングの変化のタイミングをランダムに変える。これにより、更に現実に近い陸上移動通信伝搬環境を模擬することが可能となる。

【００１２】本発明の他の実施形態によれば、制御装置は、距離減衰を一定のまま、シャドーイングを変化させる。これにより、シャドーイングのみの影響を切り分けて評価できる。

【００１３】本発明の他の実施形態によれば、フェージングシミュレータを組み合わせて、前記制御装置が該フェージングシミュレータも制御する。これにより、瞬時変動、距離減衰及びシャドーイングの全ての模擬を可能とする。

【００１４】本発明の他の実施形態によれば、制御装置は、移動局の移動速度の変化に応じてフェージングを変化させる。

【００１５】本発明の他の実施形態によれば、減衰器が、ＰＩＮダイオード連続可変減衰器である。これにより、減衰量を連続的に変化させられるため、減衰量の瞬断があると評価が狂うＣＤＭＡ方式の特性を評価できる。

【００１６】本発明の他の実施形態によれば、制御装置は、伝搬路のパラメータ並びに移動局の移動経路及び移動速度を外部から設定されるように構成されている。

【００１７】

【発明の実施の形態】以下では、図面を用いて本発明のマルチセル伝搬環境模擬装置を詳細に説明する。

【００１８】図１は、本発明のマルチセル伝搬環境模擬装置の基本構成図である。該装置は、制御装置２と、該制御装置２から制御される減衰器１１１、１１２、１１３、１１４、１ｎ１、１ｎ２、１ｎ３及び１ｎ４と、減衰器制御線３６とを有する。制御装置２は、パラメータ設定部２１と、制御部２２と、基地局１～ｎシャドーイング生成部２３と、基地局１～ｎ距離変動生成部２９と、減衰器制御部３５とを有する。基地局１～ｎシャドーイング生成部２３は、パラメータ変換部２４と、対数正規分布に従う乱数生成部２５と、相関処理部２６と、時間サンプリング部２７と、移動平均部２８とを有する。基地局１～ｎ距離変動生成部２９は、パラメータ変換部３０と、移動局走行速度．走行コース処理部３１と、移動局～基地局間距離計算部３２と、距離変動生成部３３とを有する。

【００１９】まず最初に、基地局１～ｎシャドーイング生成部２３の機能動作を説明する。シャドーイングの生成法は多数あり、例えば、乱数を生成してシャドーイングとする生成法がある。本実施形態では、例えば、乱数として正規分布に従う乱数（正規乱数）を生成して、正規乱数からシャドーイングを生成する方法を以下に説明する。

【００２０】パラメータ変換部２４は、パラメータ設定部２１から設定されるパラメータを管理し、その後の処理に必要な別のパラメータを求める。その設定されるパラメータとは、対数正規乱数標準偏差st、対数正規乱数平均値av、平均ビル幅W、移動平均幅Nw、移動局移動速度V0、移動局移動時間T1、相関係数ρ、サンプリング周波数Fsである。これらのパラメータから、シャドーイング平均周期ΔTf、正規乱数個数N1が求められる。

$\Delta Tf = W/V0$　　$N1 = T1/\Delta Tf$

【００２１】対数正規分布に従う乱数生成部２５は、対数正規乱数標準偏差st、対数正規乱数平均値avを用いて対数が正規分布に従う乱数（対数正規乱数）N1個を、（N3＋α）組生成する。N3は制御したい伝搬路数に応じて異なる。例えば、N制御する基地局数N4、１基地局あたりの制御する伝搬路数N5から、N3＝N4×N5のようにも表せる。例えば、N5は、上りリンク／下りリンクの伝搬路数、上り下りリンクの独立/共通制御により変化する。αは、相関を求める伝搬路数の組合わせにより変化する。例えば、N4＝n、N5＝1、n組（＝n基地局）間の相関を求める場合には、α＝１を用いることもできる。

【００２２】各組毎に生成された対数正規乱数は、シャドーイング平均周期ΔTf毎に発生するデータと考えられる。

【００２３】時間サンプリング部２７は、それらの各組毎の対数正規乱数N1個を、サンプリング周期Δ1/Fsでサンプリングして、N2個のデータを生成する。N3+α組の全組分のデータをサンプリングする。

【００２４】相関処理部２６は、（N3＋α）組のサンプリング済みのデータから、相関演算によって、N3組(各組毎にN2個から構成される)のデータを生成する。例えば、N4＝n、N5＝1、α＝1の場合には、N3＝nであり、組番号i=1～n+1(＝N3+α)、組毎のデータ番号j＝1～N2に対して、下記のようにｎ組分の相関演算を行うこともできる。i組目（基地局i）用のシャドーイングデータ[i,j]は、

ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ[i=1,j] ＝ sqrt(ρ)×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ[i=n+1,j] ＋sqrt(1−ρ)×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ[i=1,j]

ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ[i=2,j] ＝ sqrt(ρ)×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ[i=n+1,j] ＋sqrt(1−ρ)×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ[i=2,j]

：

ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ[i=n,j] ＝ sqrt(ρ)×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ[i=n+1,j] ＋sqrt(1−ρ)×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ[i=n,j]

【００２５】移動平均部２８は、各組毎に、相関処理部の処理結果の移動平均を求める。i組目（基地局i）用の移動平均データ[i,j]の求め方の一例を次のように示す。

移動平均ﾃﾞｰﾀ[i=1,j]＝($\sum^{Nw-1}$ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ[i=1,j])÷Nw

移動平均ﾃﾞｰﾀ[i=2,j]＝($\sum^{Nw-1}$ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ[i=2,j])÷Nw

：

移動平均ﾃﾞｰﾀ[i=n,j]＝($\sum^{Nw-1}$ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ[i=n,j])÷Nw

【００２６】次に、基地局１～ｎ距離変動生成部２９の機能動作を以下に説明する。距離変動の生成法は多数あり、関数ｆ（パラメータ）で表せる。このパラメータは、周波数、基地局高さ、移動局高さ、移動局基地局間距離等である。本実施例では、例えば、関数ｆ（）を

ｆ(移動局基地局間距離)＝$A\times 10\cdot\log_{10}$(移動局基地局間距離)＋B

とした例を以下の通りに示す。

【００２７】パラメータ変換部３０は、パラメータ設定部２１から設定されるパラメータを管理し、その後の処理に必要な別パラメータに変換する。設定されるパラメータとは、基地局座標、移動局走行コース（初期位置，最終位置、移動速度、移動座標）、パラメータA,Bである。この他に用いるパラメータは、パラメータ変換部２４の変換結果を流用する。

【００２８】パラメータA,Bは、距離変動生成式から算出される。本発明では、パラメータA,Bをパラメータ設定部２１から直接設定してもよいし、距離変動式に必要なパラメータをパラメータ設定部から入力して、距離変動式の演算をパラメータ変換部３０内で行ってパラメータA,Bを算出してもよい。

【００２９】移動局走行速度,走行コース処理部３１は、移動局の走行コースを求める。移動局の初期位置、最終位置,移動速度から、移動局の直線移動コースや円移動コースを仮定して、各時刻毎の移動局位置を求めてもよいし、時刻毎の移動局座標を収めた座標データを直接にパラメータ設定部２１から設定してもよい。

【００３０】移動局～基地局間距離計算部３２は、時間間隔Δ1/FS毎の移動局座標とN4個の基地局間座標から各時刻毎の移動局と基地局間距離を、1基地局あたりN2個ずつ求める。

【００３１】距離変動生成部３３は、各時刻毎、各基地局毎の距離変動をパラメータA,Bを用いて求める。i組目（基地局i用）の距離変動データ[i,j]は、次のように求められる。

距離変動ﾃﾞｰﾀ[i=1,j]＝$A\times\log_{10}$(移動局と基地局1間距離のj番目)＋B

距離変動ﾃﾞｰﾀ[i=2,j]＝$A\times\log_{10}$(移動局と基地局2間距離のj番目)＋B

：

距離変動ﾃﾞｰﾀ[i=n,j]＝$A\times\log_{10}$(移動局と基地局n間距離のj番目)＋B

【００３２】次に、基地局１～ｎ伝搬損生成部３４の機能動作を以下に説明する。

【００３３】シャドーイングデータと距離変動デタを加算して、伝搬損データを生成する。i組目（基地局i用）の伝搬損データ[i,j]は、次のように求められる。

伝搬損ﾃﾞｰﾀ[i=1,j] ＝ 移動平均ﾃﾞｰﾀ[i=1,j]＋距離変動データ[i=1,j]

伝搬損ﾃﾞｰﾀ[i=2,j] ＝ 移動平均ﾃﾞｰﾀ[i=2,j]＋距離変動データ[i=2,j]

：

伝搬損ﾃﾞｰﾀ[i=n,j] ＝ 移動平均ﾃﾞｰﾀ[i=n,j]＋距離変動データ[i=n,j]

【００３４】伝搬損データに、アンテナ利得の指向特性を加算して、制御データを生成する。i組目（基地局i用）の制御データ[i,j]は、次のように求められる。

制御ﾃﾞｰﾀ[i=1,j] ＝ f1(伝搬損ﾃﾞｰﾀ[i=1,j]、Θ_1)

制御ﾃﾞｰﾀ[i=2,j] ＝ f2(伝搬損ﾃﾞｰﾀ[i=2,j]、Θ_2)

：

制御ﾃﾞｰﾀ[i=n,j] ＝ fn(伝搬損ﾃﾞｰﾀ[i=n,j]、Θ_n)

【００３５】f1～fnは各々アンテナ利得の指向性パターンの関数であり、Θ_1～Θ_nはアンテナ利得の指向特性の中心方向と、基地局と移動局を結ぶ直線がなす角度である。

【００３６】次に、減衰器制御部３５の機能動作を以下に説明する。

【００３７】シャドーイングデータと距離変動データが加算されて、アンテナ利得指向性パターンが加味された制御データから、減衰器を制御する制御信号を生成する。

【００３８】例えば、電圧制御される減衰器（加える電圧に応じて、減衰量が変化する）であれば、制御データを減衰器の制御電圧対減衰量特性に合わせて、アナログ電圧信号に変換する。

【００３９】例えば、電圧０Ｖ時に減衰量０ｄＢ、１０Ｖ時に６０ｄＢの減衰器であれば、D/A変換を行って、０ｄＢのデータを０Ｖに、６０ｄＢのデータを１０Ｖのアナログ電圧に変換する。

【００４０】例えば、アナログ電流を用いて制御される減衰器の場合、制御電流対減衰量特性に合わせて、制御データをアナログ電流信号に換算する。

【００４１】例えば、ディジタル信号を用いて制御される減衰器の場合、ディジタル制御信号対減衰量特性に合わせて、制御データをディジタル制御信号に換算する。

【００４２】制御データの減衰量範囲が減衰器１１１～１１４、１ｎ１～１ｎ４の制御範囲を超えている場合、補正を行う。例えば、制御データが９０ｄＢ～１５０ｄＢの範囲で変化している場合には、これを(固定分９０ｄＢ＋可変分６０ｄＢ)に分割して、可変分のみを制御装置２の制御対象とすることで、制御データを減衰器１１１～１１４、１ｎ１～１ｎ４の制御範囲に収められる。この場合、固定分９０ｄＢを別途用意する固定減衰器で設定し、０～６０ｄＢの可変分のみをアナログ電圧信号、アナログ電流信号、ディジタル制御信号等の制御信号に変換する。

【００４３】変換された制御信号は、減衰器制御信号線３６を経由して、減衰器１１１～１１４、１ｎ１～１ｎ４に送られて、制御が行われる。

【００４４】このように、前述した実施形態では、制御データを制御の開始以前に一括して作成するものであった。

【００４５】一方で、他の実施形態として、制御データの作成を、制御の実行と同時並行して行うリアルタイム制御データ生成→制御実行の形式をとる実装も、何の問題もなく可能である。この場合、移動平均処理時、制御時点の時刻よりも、先の時刻のデータが必要になるが、それを見越して先行してデータを作成することで対処可能である。

【００４６】次に、他の実施形態として、制御対象の減衰器に、ＰＩＮダイオード連続可変減衰器を用いることで、途切れることが無い連続した減衰量の変化が可能である。

【００４７】ＰＩＮダイオードを用いない一般のステップ減衰器を用いると、制御信号量の変化毎に瞬間的に減衰量が予期しない値（例：制御信号の大きさが変わる毎に、減衰量が瞬間的に最大になり、しばらく時間が経過すると、制御信号通りの減衰量に収束する）に設定される場合があるため、ＣＤＭＡ方式を用いる陸上移動通信の評価には適さない。

【００４８】次に、他の実施形態として、アンテナ利得の指向性パターンに指向性アンテナパターンを用いることで、陸上移動通信におけるセクタセルを実現できる。セクタセルは、１個のセルを、セクタと呼ばれる複数の領域に分割して、セクタ毎に専用のアンテナを用意して、セルをカバーする手法である。

【００４９】例えば指向性が１２０度の指向性アンテナを１２０度毎にずらして配置するセルは３セクタセルと呼ばれる。制御装置２に、基地局位置座標を同一とする３個の基地局を設定して、各基地局のアンテナ利得の指向性パターンを１２０度ずつずらして制御装置２に設定することで、本発明は３セクタセルを実現できる。このようにすれば、６セクタセル，１２セクタセル等のように、３セクタセル以外のセクタセルも模擬可能である。

【００５０】図２は、本発明によるマルチセル伝搬環境模擬装置を用いて構成した、３基地局及び１移動局の陸上移動通信測定環境の構成図である。該図２は、本発明を、瞬時変動を模擬するフェージングシミュレータと組み合わせることにより、陸上移動伝搬環境を模擬している。

【００５１】図２の陸上移動通信測定環境では、基地局１送信アンテナ端３７、基地局ｎ送信アンテナ端３８、基地局１受信アンテナ端１及び２である３９、基地局ｎ受信アンテナ端１及び２である４０、フェージングシミュレータ５、分配器４１、合成器４２、制御範囲補正用固定減衰器４３、移動局受信アンテナ端１及び２である６１、移動局送信アンテナ端６２を含む。該制御範囲補正用固定減衰器４３は、減衰器制御部３５の機能動作で説明した制御範囲補正用の固定減衰器である。

【００５２】図３は、図２のフェージングシミュレータ５を制御する機能を制御装置２に付加した陸上移動通信測定環境の構成図である。制御信号線３６は、フェージングシミュレータの制御用信号も転送する。

【００５３】フェージングシミュレータ５が用いるパラメータと、本発明が用いるパラメータに共通するパラメータは、移動局移動速度、パラメータA,Bの算出式に必要なパラメータ類であり、それらは制御装置２から一括して設定される。

【００５４】前述した基地局１～ｎシャドーイング生成部２３では、時間サンプリング部２７処理後の（$N3+\alpha$）組のサンプリング済みデータは、全て同期して値が変化する。これを変更し、各組毎に、値が変化するタイミングを変更することにより、より現実に近い伝搬環境を再現できる。

【００５５】値が変化するタイミングを、各組毎の組単位でずらすことは、例えば（$N3+\alpha$）組の一様乱数Ri（$i=1$～$N3+\alpha$、Riの値域0～1）を発生し、$Si = Ri \times \Delta Tf \times Fs$サンプリング（サンプリング周波数Fs）を求めて、相関処理部２６で演算をする際に、各組毎にSiサンプリングタイミングずつずらして、演算をすることで可能である。すなわち、i組目の相関処理後のｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ$[i,j]$は、次のように求められる。

ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ$[i=1, j+S_1]$ = $\mathrm{sqrt}(\rho)$×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ$[i=n+1, j+S_{n+1}]$ ＋ $\mathrm{sqrt}(1-\rho)$×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ$[i=1, j+S_1]$

ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ$[i=2, j+S_2]$ = $\mathrm{sqrt}(\rho)$×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ$[i=n+1, j+S_{n+1}]$ ＋ $\mathrm{sqrt}(1-\rho)$×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ$[i=2, j+S_2]$

：

ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ$[i=n, j+S_n]$ = $\mathrm{sqrt}(\rho)$×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ$[i=n+1, j+S_{n+1}]$ ＋ $\mathrm{sqrt}(1-\rho)$×ｻﾝﾌﾟﾘﾝｸﾞ済みﾃﾞｰﾀ$[i=n, j+S_n]$

【００５６】各組毎に異なるタイミング分後ろにずらす際に、ずらした分のデータには一律０を入れる等の工夫を行う。

【００５７】値が変化するタイミングを、対数正規乱数単位でランダムに変化させることとは例えば、（$N3+\alpha$）組の一様乱数$R_{i,j}$（$i=1\sim N3+\alpha$、$j=1\sim N1$、R_iの値域−０．５〜０．５）を発生し、$T_{i,j} = R_{i,j} \times \Delta T_f \times F_s$を求めて、($N3+\alpha$)組のサンプリング済みデータに対して、データが変化するタイミングを$T_{i,j}$サンプリングタイミングずつずらすことで可能である。

【００５８】値が変化するタイミングを、組毎に変えて、更に対数正規乱数単位でランダムに変化させるためには、本実施形態内の上記２種類の処理を併せて行えば実現される。

【００５９】以上、詳細に説明した実施形態において、本発明の技術思想及び見地の範囲内での種々の変更、修正及び省略は、当業者によれば容易に行うことができる。従って、前述した実施形態はあくまで例であって、何等制約しようとするものではない。本発明は、特許請求の範囲及びその均等物として限定されるものだけに制約される。

【００６０】

【発明の効果】以上説明したように、本発明によるマルチセル伝搬環境模擬装置によれば、複数基地局（マルチセル及びマルチセクタセル）環境下での移動局の動作・性能を評価できる。

【００６１】また、制御装置が、上りリンク及び下りリンクを個別に制御することにより、上りリンクと下りリンクの伝搬特性の違いを反映できる。

【００６２】更に、制御装置が、距離減衰を一定に設定して、シャドーイングのみを制御することにより、シャドーイングのみの影響を切り分けて評価できる。

【００６３】更に、移動局の移動経路、移動速度を設定することにより、移動局の移動パターンの影響を評価できる。

【００６４】更に、ＰＩＮダイオード連続可変減衰器を用いることにより、減衰量を連続的に変化させられるため、減衰量の瞬断があると評価が狂うＣＤＭＡ方式の特性を評価できる。

【００６５】更に、基地局毎に、シャドーイングの変化のタイミングをランダムに変えることにより、更に現実に近い陸上移動通信伝搬環境を模擬することが可能となる。

【００６６】更に、フェージングシミュレータと本発明を組み合わせて、本発明からフェージングシミュレータを制御することにより、任意の陸上移動通信伝搬環境を模擬することが可能となる。

【図面の簡単な説明】

【図１】本発明のマルチセル伝搬環境模擬装置の基本構成図である。

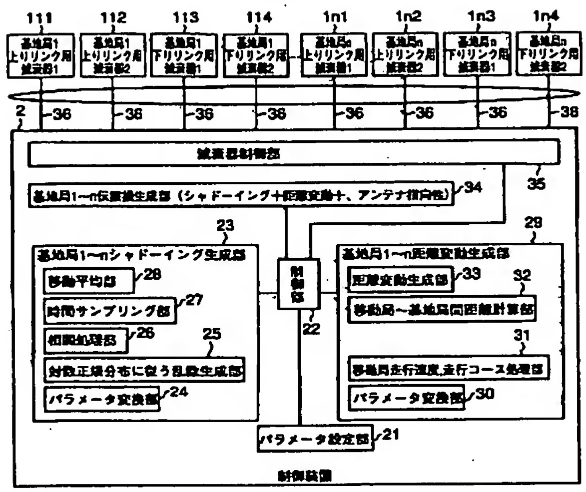
【図２】本発明によるマルチセル伝搬環境模擬装置を用いて構成した、３基地局及び１移動局の陸上移動通信測定環境の構成図である。

【図３】図２のフェージングシミュレータ５を制御する機能を制御装置２に付加した陸上移動通信測定環境の構成図である。

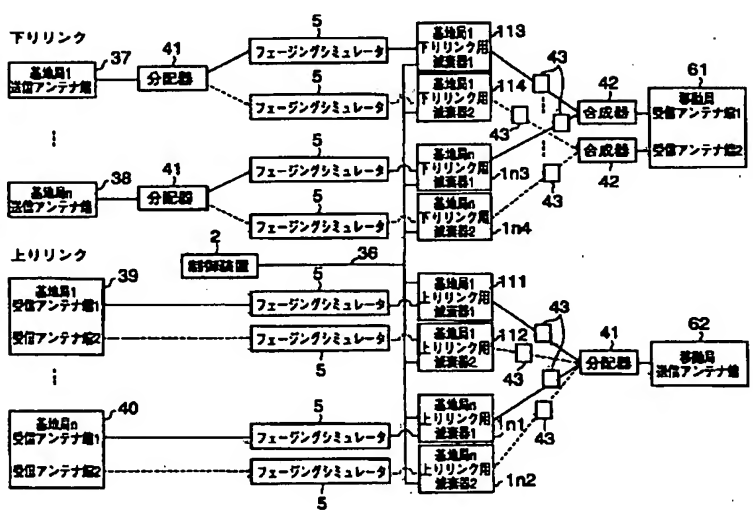
【符号の説明】

１１１　基地局１上りリンク用減衰器１
１１２　基地局１上りリンク用減衰器２
１１３　基地局１下りリンク用減衰器１
１１４　基地局１下りリンク用減衰器２
１ｎ１　基地局ｎ上りリンク用減衰器１
１ｎ２　基地局ｎ上りリンク用減衰器２
１ｎ３　基地局ｎ下りリンク用減衰器１
１ｎ４　基地局ｎ下りリンク用減衰器２
２　制御装置
２１　パラメータ設定部
２２　制御部
２３　基地局１〜ｎシャドーイング生成部
２４　パラメータ変換部
２５　対数正規分布に従う乱数生成部
２６　相関処理部
２７　時間サンプリング部
２８　シャドーイング変幹部
２９　基地局１〜ｎ距離変動生成部
３０　パラメータ変換部
３１　移動局走行速度・走行コース処理部
３２　移動局〜基地局間距離計算部
３３　距離変動生成部
３４　基地局１〜ｎ伝搬損生成部（シャドーイング＋距離変動+アンテナ指向性）
３５　減衰器制御部
３６　減衰器制御線
３７　基地局１送信アンテナ端
３８　基地局ｎ送信アンテナ端
３９　基地局１受信アンテナ端１及び２
４０　基地局ｎ十進アンテナ端１及び２
４１　分配器
４２　合成器
４３　制御範囲補正用固定減衰器
５　フェージングシミュレータ
６１　移動局受信アンテナ端１及び２
６２　移動局受信送信アンテナ端

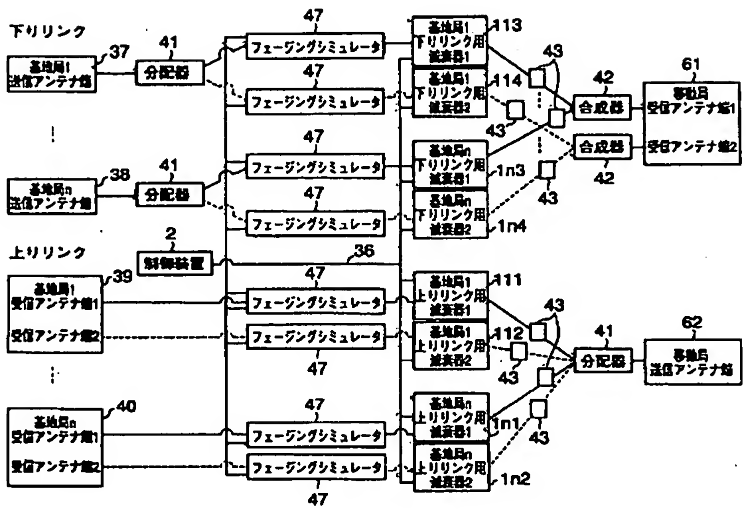
【図１】



【図２】



【図３】



フロントページの続き

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5K067 AA02 CC10 DD47 EE02 EE10 EE24 EE32 LL08

CLAIMS

[Claim(s)]
[Claim 1] It is the multi-cell propagation environmental mimicking device characterized by controlling the magnitude of attenuation of an attenuator to have two or more attenuators and the control unit which controls the magnitude of attenuation of this attenuator, and for this control unit to set up beforehand the orientation pattern of the imagination location of one set of a mobile station, and two or more base stations, and the sector antenna of each base station, and to carry out false [of the propagation loss of two or more propagation paths between a mobile station and a base station].
[Claim 2] Said propagation loss is equipment according to claim 1 characterized by being a decay by distance and/or shadowing.
[Claim 3] Said control unit is equipment according to claim 1 or 2 characterized by setting up beforehand the imagination moving trucking and the passing speed of said mobile station, and changing propagation loss according to migration of said mobile station.
[Claim 4] Equipment according to claim 2 or 3 characterized by generating the random number which follows log normal distribution, using a standard deviation and an average value as a parameter including correlation between the two or more ground offices per mean wave period which can be found from average building width of face and mobile station passing speed, and making the moving average of this random number into said shadowing for said every base station.
[Claim 5] said control unit be equipment according to claim 3 or 4 characterize by calculate said propagation loss which change with migration of this mobile station by move said mobile station to the base station location set up and the orientation pattern of the sector antenna of each base station , and a propagation path parameter list virtually with the passage of time based on mobile station moving trucking and passing speed , and control two or more external attenuators serially according to this propagation loss .
[Claim 6] Said control unit is equipment given in the going-up link of mobile station transmission and base station reception, and any 1 term of claims 2-5 characterized by for base station transmission and mobile station reception getting down, and controlling a link independently.
[Claim 7] Said control unit is equipment given in any 1 term of claims 3-6 characterized by changing the timing of change of said shadowing at random for said every base station.
[Claim 8] Said control unit is equipment given in any 1 term of claims 2-7 characterized by said decay by distance changing said shadowing while it has been fixed.
[Claim 9] Equipment given in any 1 term of claims 2-8 characterized by said control device controlling this phasing simulator combining a phasing simulator.
[Claim 10] Said control device is equipment according to claim 9 characterized by changing phasing according to change of the passing speed of said mobile station.
[Claim 11] Equipment given in any 1 term of claims 1-10 to which said attenuator is characterized by being PIN diode continuation variable attenuator.
[Claim 12] Said control unit is equipment given in any 1 term of claims 3-11 characterized by the ability to set the moving trucking and passing speed of a mobile station as the parameter list of a propagation path from the outside.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the propagation environmental mimicking device for simulating simply the wireless propagation environment of a land-mobile communication link.
[0002]
[Description of the Prior Art] The wireless propagation loss of a land-mobile communication link is considered as a result which three kinds of properties, (a) instant fluctuation, the short section median fluctuation by (b) shadowing, and the (c) decay by distance, superimposed (Masaaki Shinshi work "mobile communication" P.55, Maruzen Co., Ltd. **). Conventionally, the propagation environmental mimicking device is made in order to measure the basic property of wireless propagation, and it makes only instant fluctuation applicable to a simulation.
[0003]
[Problem(s) to be Solved by the Invention] However, since a phasing simulator was not able to simulate shadowing and a decay by distance, when the mobile station was moving, it was not able to evaluate actuation and the engine performance of application properties, such as a handover (actuation which changes a base station with migration of a mobile station).
[0004] Then, also when the mobile station is moving, this invention offers the multi-cell propagation environmental mimicking device which simulates shadowing and a decay by distance so that a property can be evaluated.
[0005]
[Means for Solving the Problem] Therefore, the multi-cell propagation environmental mimicking device by this invention has two or more attenuators and the control unit which controls the magnitude of attenuation of this attenuator, and this control unit sets up beforehand the orientation pattern of the imagination location of one set of a mobile station, and two or more base stations, and the sector antenna of each base station, and controls the magnitude of attenuation of an attenuator to carry out false [of the propagation loss of two or more propagation paths between a mobile station and a base station]. Thereby, actuation and the engine performance of the mobile station under two or more sets ground office (multi-cell and multisector cel) environment can be evaluated.
[0006] According to other operation gestalten of this invention, propagation loss is a decay by distance and/or shadowing.
[0007] According to other operation gestalten of this invention, a control unit sets up beforehand the imagination moving trucking and the passing speed of a mobile station, and changes propagation loss according to migration of a mobile station. Thereby, the effect of the migration pattern of a mobile station can be evaluated.
[0008] According to other operation gestalten of this invention, the random number which follows log normal distribution, using a standard deviation and an average value as a parameter is generated including correlation between the two or more ground offices per mean wave period which can be found from average building width of face and mobile station passing speed, and let the moving average of this random number be shadowing for every base station.
[0009] According to other operation gestalten of this invention, a control unit moves said mobile

station to the base station location set up and the orientation pattern of the sector antenna of each base station, and a propagation path parameter list virtually with the passage of time based on mobile station moving trucking and passing speed, calculates said propagation loss which changes with migration of this mobile station, and controls two or more external attenuators serially according to this propagation loss.
[0010] According to other operation gestalten of this invention, the going-up link of mobile station transmission and base station reception, and base station transmission and mobile station reception get down, and a control unit controls a link independently. Thereby, it gets down with an uphill link and the difference in the propagation property of a link can be reflected.
[0011] According to other operation gestalten of this invention, a control unit changes the timing of change of shadowing at random for every base station. It becomes possible to simulate a land-mobile communication link propagation environment near thereby still more nearly actually.
[0012] According to other operation gestalten of this invention, as for a control unit, a decay by distance changes shadowing, while it has been fixed. Thereby, the effect only of shadowing can be carved and evaluated.
[0013] According to other operation gestalten of this invention, said control device also controls this phasing simulator combining a phasing simulator. Thereby, all simulations of instant fluctuation, a decay by distance, and shadowing are enabled.
[0014] According to other operation gestalten of this invention, a control device changes phasing according to change of the passing speed of a mobile station.
[0015] According to other operation gestalten of this invention, an attenuator is PIN diode continuation variable attenuator. Thereby, since the magnitude of attenuation is changed continuously, if there are hits of the magnitude of attenuation, the property of a CDMA method that assessment is out of order can be evaluated.
[0016] According to other operation gestalten of this invention, the control unit is constituted so that the moving trucking and passing speed of a mobile station may be set as the parameter list of a propagation path from the outside.
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[Embodiment of the Invention] Below, the multi-cell propagation environmental mimicking device of this invention is explained to a detail using a drawing.
[0018] Drawing 1 is the basic block diagram of the multi-cell propagation environmental mimicking device of this invention. This equipment has the attenuators 111, 112, 113, and 114 controlled from a control unit 2 and this control unit 2, 1n1, 1n2, 1n3 and 1n4, and the attenuator control line 36. A control unit 2 has the parameter setup section 21, a control section 22, a base station 1 − n shadowing generation section 23, a base station 1 − n distance fluctuation generation section 29, and the attenuator control section 35. A base station 1 − n shadowing generation section 23 have the parameter converter 24, the random-number generation section 25 according to log normal distribution, the correlation processing section 26, the time amount sampling section 27, and the moving-average section 28. A base station 1 − n distance fluctuation generation section 29 have the parameter converter 30, a mobile station travel speed and the transit course processing section 31, the distance count section 32 between a mobile station − base stations, and the distance fluctuation generation section 33.
[0019] First, functional actuation of a base station 1 − n shadowing generation section 23 is explained. For example, it has the generating method which generates a random number and is made into shadowing. [the method of generating shadowing] This operation gestalt explains below how to generate the random number (normal random number) which follows normal distribution as a random number, for example, and generate shadowing from the normal random number.
[0020] The parameter converter 24 manages the parameter set up from the parameter setup section 21, and asks for another parameter required for subsequent processing. the parameter set up -- a logarithm -- the normal random number standard deviation st and a logarithm -- they are the normal random number average value av, the average building width of face W, the moving-average width of face Nw, the mobile station passing speed V0, the mobile station transit time T1, a correlation coefficient rho, and a sampling frequency Fs. From these parameters,

shadowing mean wave period deltaTf and the normal random number number N1 are called for. deltaTf=W/V0 N1=T1/deltaTf[0021] the random-number generation section 25 according to log normal distribution -- a logarithm -- the normal random number standard deviation st and a logarithm -- a logarithm carries out group (N3+alpha) generation of the one random number (logarithm normal random number) N according to normal distribution using the normal random number average av. N3 differs according to the number of propagation paths to control. For example, it can express also like N3=N4xN5 from N4 base stations which carry out N control, and N5 propagation paths which around one base station controls. For example, it link [uphill]/Gets down and N5 changes with the number of propagation paths of a link, and independence/common control of a rise-and-fall link. alpha changes with the combination of the number of propagation paths which searches for correlation. For example, alpha= 1 can also be used when searching for correlation between N4=n, N5=1, and an n-tuple (=n base station).

[0022] the logarithm generated for each class -- the normal random number is considered to be data generated for every shadowing mean wave period deltaTf.

[0023] the time amount sampling section 27 -- the logarithm for those each class -- the one normal random number N is sampled with sampling periods delta1/Fs, and the data of two N are generated. The data of all the grouping of an N3+alpha group are sampled.

[0024] The correlation processing section 26 generates the data of 3 sets (it consists of two N for each class) of N by the correlation operation from data [finishing / the sampling of a group (N3+alpha)]. For example, in the case of N4=n, N5=1, and alpha= 1, it is N3=n and the correlation operation for an n-tuple can also be performed as follows to the group number i= 1 to n+1 (=N3+alpha), the data number j= 1 for every group - N2. The shadowing data [i, j] for [i set] (base station i) Shadowing data [i= 1, j] = data [i=n +1, j] sampled [sqrt(rho) x] + sqrt (1-rho) i= 1 and the sampled [x] [data j] shadowing data [i= 2, j] Data sampled [= sqrt(rho) x] [i=n +1, j] Data sampled [+sqrt(1-rho) x] [i= 2, j] : Shadowing data [i=n, j] Data sampled [= sqrt(rho) x] [i=n +1, j] +sqrt(1-rho) x sampling ending [i=n and Data j] [0025] The moving-average section 28 asks for the moving average of the processing result of the correlation processing section for each class. An example of how to ask for the moving-average data [i, j] for [i set] (base station i) is shown as follows.

$$\text{移動平均ﾃﾞｰﾀ}[i=1, j]=\left(\sum^{Nw-1}\text{ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ}[i=1, j]\right)\div Nw$$

$$\text{移動平均ﾃﾞｰﾀ}[i=2, j]=\left(\sum^{Nw-1}\text{ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ}[i=2, j]\right)\div Nw$$

$$\vdots$$

$$\text{移動平均ﾃﾞｰﾀ}[i=n, j]=\left(\sum^{Nw-1}\text{ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ}[i=n, j]\right)\div Nw$$

[0026] Next, functional actuation of a base station 1 - n distance fluctuation generation section 29 is explained below. And it can be expressed with Function f (parameter). [the method of generating distance fluctuation] This parameter is a frequency, base station height, mobile station height, the distance between mobile station base stations, etc. This example shows as follows the example which set function f() to f(distance between mobile station base stations) =Ax10, andlog10(distance between mobile station base stations) +B, for example.

[0027] The parameter converter 30 manages the parameter set up from the parameter setup section 21, and changes it into another parameter required for subsequent processing. The parameters set up are a base station coordinate, a mobile station transit course (an initial position, the last location, passing speed, migration coordinate), and Parameters A and B. In addition, the parameter to be used diverts the conversion result of the parameter converter 24.

[0028] Parameters A and B are computed from a distance fluctuation generation type. In this invention, Parameters A and B may be computed by setting up Parameters A and B directly from the parameter setup section 21, inputting a parameter required for a distance fluctuation type from the parameter setup section, and calculating a distance fluctuation type within the parameter converter 30.

[0029] A mobile station travel speed and the transit course processing section 31 ask for the transit course of a mobile station. From the initial position of a mobile station, the last location, and passing speed, the straight-line migration course and circle migration course of a mobile station may be assumed, you may ask for the mobile station location for every time of day, and the coordinate data which stored the mobile station coordinate for every time of day may be directly set up from the parameter setup section 21.
[0030] The distance count section 32 between a mobile station – base stations finds two N per one base station at a time the mobile station for every time of day, and the distance between base stations from the mobile station coordinate for every time intervals delta1/FS, and the base station spacer label of four N.
[0031] The distance fluctuation generation section 33 asks for every time of day and the distance fluctuation for every base station using Parameters A and B. The i-th (for base station i) set of distance fluctuation data [i, j] are called for as follows.
Distance fluctuation [Data [i= 1 and] j] =Axlog10(the j-th of a mobile station and the distance between base stations 1)+B distance fluctuation [Data [i= 2 and] j] =Axlog10(the j-th of a mobile station and the distance between base stations 2)+B: Distance fluctuation [i=n and Data j] =Axlog10(the j-th of mobile station and distance between base stations n)+B [0032] Next, functional actuation of a base station 1 – n propagation loss generation section 34 is explained below.
[0033] Shadowing data and distance fluctuation data are added and propagation loss data are generated. The i-th (for base station i) set of propagation loss data [i, j] are called for as follows.

propagation loss data [i= 1, j] = i= 1 and the i= 1 and moving-average [data j] + distance fluctuation [data j] propagation loss data [i= 2, j] = i= 2 and i= 2 and moving-average [data j] + distance fluctuation [data j]:propagation loss data [i=n, j] = [moving-average [i=n and Data j] + distance fluctuation data -- i=n, j [0034]] The directional characteristics of antenna gain are added to propagation loss data, and control data is generated. The i-th (for base station i) set of control data [i, j] are called for as follows.
Control data [i= 1, j] = f1 (propagation loss data [i= 1, j], theta 1) control data [i= 2, j] = f2 (propagation-loss data [i= 2, j], theta 2): Control data [i=n, j] = fn (propagation loss data [i=n, j], thetan) [0035] f1-fn are the functions of the directivity response pattern of antenna gain respectively, and theta 1 – thetan are include angles which the straight line which connects a base station and a mobile station to the direction of a core of the directional characteristics of antenna gain makes.
[0036] Next, functional actuation of the attenuator control section 35 is explained below.
[0037] Shadowing data and distance fluctuation data are added and the control signal which controls an attenuator is generated from the control data with which the antenna gain directivity response pattern was considered.
[0038] For example, if it is the attenuator (the magnitude of attenuation changes according to the electrical potential difference to apply) by which armature-voltage control is carried out, control data will be set by the control voltage pair magnitude-of-attenuation property of an attenuator, and it will change into an analog voltage signal.
[0039] For example, if it is a 60dB attenuator at 0dB of magnitude of attenuation, and 10 V:00, D/A conversion is performed, 0dB data will be changed into 0V, and 60dB data will be changed into the analog voltage of 10V at electrical-potential-difference 0 V:00.
[0040] For example, in the case of the attenuator controlled using an analog current, control data is converted into an analog current signal according to a control current pair magnitude-of-attenuation property.
[0041] For example, in the case of the attenuator controlled using a digital signal, control data is converted into a digital control signal according to a digital control signal pair magnitude-of-attenuation property.
[0042] The magnitude-of-attenuation range of control data amends, when it is over 1n 1-1n of control ranges of 4, attenuators 111-114 and. For example, when the control data is changing in 90dB – 150dB, control data is stored in attenuators 111-114 and the control range of 1n1-1n4

by dividing this into 90dB + adjustable 60dB), and making only a part for adjustable into the controlled system of a control device 2. [of (fixed parts] [per part] In this case, it sets up with the fixed attenuator which prepares 90dB of fixed parts separately, and only a part for adjustable [of 0-60dB] is changed into control signals, such as an analog voltage signal, an analog current signal, and a digital control signal.
[0043] The changed control signal is sent to attenuators 111-114 and 1n1-1n4 via the attenuator control signal line 36, and control is performed.
[0044] Thus, it was what creates control data collectively with the operation gestalt mentioned above before initiation of control.
[0045] On the other hand, it has [mounting which takes the format of Real Time Control data generation -> control activation of carrying out the concurrency of the creation of control data to activation of control, and performing it as other operation gestalten] any problem and is possible. In this case, although the data of previous time of day are needed from the time of day at the control event at the time of moving-average processing, it can be coped with by foreseeing and preceding it and creating data.
[0046] Next, change of the continuous magnitude of attenuation which does not break off as other operation gestalten by using PIN diode continuation variable attenuator for the attenuator of a controlled system is possible.
[0047] If the common step attenuator which does not use a PIN diode is used, since it may be set as the value (example: it will converge on the magnitude of attenuation as a control signal if the magnitude of attenuation becomes max momentarily and time amount passes for a while whenever the magnitude of a control signal changes) which the magnitude of attenuation does not expect momentarily for every change of the amount of control signals, it is not suitable for assessment of the land-mobile communication link using a CDMA method.
[0048] Next, the sector cel in a land-mobile communication link is realizable as other operation gestalten by using a directive antenna pattern for the directivity response pattern of antenna gain. A sector cel is the technique of dividing one cel into two or more fields called a sector, preparing the antenna of dedication for every sector, and covering a cel.
[0049] For example, the cel in which directivity shifts and arranges the directional antenna which is 120 degrees every 120 degrees is called 3 sector cel. This invention can realize 3 sector cel by setting three base stations which make a base station position coordinate the same as a control unit 2, shifting the directivity response pattern of the antenna gain of each base station by a unit of 120 degrees, and setting it as a control unit 2. If it does in this way, sector cels other than 3 sector cel can also be simulated like 6 sector cel and 12 sector cel.
[0050] Drawing 2 is the block diagram of the land-mobile communication link measurement environment of three base stations constituted using the multi-cell propagation environmental mimicking device by this invention, and one mobile station. This drawing 2 is simulating the land-mobile propagation environment by combining this invention with the phasing simulator which simulates instant fluctuation.
[0051] In the land-mobile communication link measurement environment of drawing 2 , 61 and the mobile station transmitting antenna edge 62 which are 39 which is the base station 1 transmitting antenna edge 37, the base station n transmitting antenna edge 38, and the base station 1 receiving-antenna edges 1 and 2, 40 which is the base station n receiving-antenna edges 1 and 2, the phasing simulator 5, a distributor 41, the synthetic vessel 42, the fixed attenuator 43 for control range amendment, and the mobile station receiving-antenna edges 1 and 2 are included. This fixed attenuator 43 for control range amendment is a fixed attenuator for control range amendment explained in functional actuation of the attenuator control section 35.
[0052] Drawing 3 is the block diagram of the land-mobile communication link measurement environment which added the function which controls the phasing simulator 5 of drawing 2 to the control unit 2. The control signal line 36 also transmits the signal for control of a phasing simulator.
[0053] The parameters common to the parameter which the phasing simulator 5 uses, and the parameter which this invention uses are mobile station passing speed and parameters required

for the formula of Parameters A and B, and they are collectively set up from a control unit 2.
[0054] In the base station 1 mentioned above - n shadowing generation section 23, all the sampled data of the group (N3+alpha) after time amount sampling section 27 processing synchronize, and a value changes. The propagation environment more near reality is reproducible by changing this and changing the timing from which a value changes for each class.
[0055] Shifting the timing from which a value changes in the group unit for each class generates the uniform random number Ri (i=1-N3+ range 0-1 of alpha and Ri) of a group (N3+alpha), and it is Si =. In case it asks for a Rixdelta TfxFs sampling (sampling frequency Fs) and calculates in the correlation processing section 26, it is possible by calculating by shifting Si sampling timing every for each class. That is, the shadowing data after the i-th set of correlation processings [i, j] are called for as follows.
shadowing data [i= 1, j+S1] = sqrt (rho) data [i=n +1, j+Sn +1] sampled [x] i= 1 and sampled [+sqrt(1-rho) x] data {j+S1] shadowing data [i= 2, j+S2] Data {i=n +1, j+Sn +1] sampled [= sqrt (rho) x] + sqrt Data sampled [x] [i= 2, j+S2] : (1-rho) Shadowing data [i=n, j+Sn] = data sampled [sqrt(rho) x] [i=n +1, j+Sn +1] +sqrt(1-rho) x sampling ending data [i=n, j+Sn] [0056] In case it shifts to different timing part back for each class, it devises putting 0 into the data to have shifted uniformly etc.
[0057] the timing from which a value changes -- a logarithm -- making it change at random per normal random number -- for example Generate the uniform random numbers Ri and j (i=1-N3+alpha, j=1- range of N1 and Ri - 0.5-0.5) of a group, calculate Ti, j = Ri, and jxdelta TfxFs, and the sampled data of a group (N3+alpha) are received. (N3+alpha) It is possible by Ti and shifting j sampling timing every in the timing from which data change.
[0058] the timing from which a value changes -- every group -- changing -- further -- a logarithm -- in order to make it change at random per normal random number, if the above-mentioned two kinds within this operation gestalt of processings are combined and are performed, it will realize.
[0059] As mentioned above, according to this contractor, in the operation gestalt explained to the detail, various modification, corrections, and abbreviations in within the limits of the technical thought of this invention and a standpoint can be performed easily. Therefore, the operation gestalt mentioned above is an example to the last, and it is not going to restrain it at all. This invention is restrained by only what is limited as a claim and its equal object.
[0060]
[Effect of the Invention] As explained above, according to the multi-cell propagation environmental mimicking device by this invention, actuation and the engine performance of the mobile station under two or more sets ground office (multi-cell and multisector cel) environment can be evaluated.
[0061] Moreover, a going-up link and by getting down and controlling a link according to an individual, a control unit gets down with an uphill link, and can reflect the difference in the propagation property of a link.
[0062] Furthermore, when a control unit sets up a decay by distance uniformly and controls only shadowing, the effect only of shadowing can be carved and evaluated.
[0063] Furthermore, the effect of the migration pattern of a mobile station can be evaluated by setting up the moving trucking of a mobile station, and passing speed.
[0064] Furthermore, since the magnitude of attenuation is continuously changed by using PIN diode continuation variable attenuator, if there are hits of the magnitude of attenuation, the property of a CDMA method that assessment is out of order can be evaluated.
[0065] Furthermore, it becomes possible by changing the timing of change of shadowing at random for every base station to simulate a land-mobile communication link propagation environment near still more nearly actually.
[0066] Furthermore, it becomes possible combining a phasing simulator and this invention to simulate the land-mobile communication link propagation environment of arbitration by controlling a phasing simulator from this invention.

[Translation done.]

* NOTICES *

TECHNICAL FIELD

[Field of the Invention] This invention relates to the propagation environmental mimicking device for simulating simply the wireless propagation environment of a land-mobile communication link.

[Translation done.]

PRIOR ART

[Description of the Prior Art] The wireless propagation loss of a land-mobile communication link is considered as a result which three kinds of properties, (a) instant fluctuation, the short section median fluctuation by (b) shadowing, and the (c) decay by distance, superimposed (Masaaki Shinshi work "mobile communication" P.55, Maruzen Co., Ltd. **). Conventionally, the propagation environmental mimicking device is made in order to measure the basic property of wireless propagation, and it makes only instant fluctuation applicable to a simulation.

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TECHNICAL PROBLEM

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[0004] Then, also when the mobile station is moving, this invention offers the multi-cell propagation environmental mimicking device which simulates shadowing and a decay by distance so that a property can be evaluated.

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JPO and INPIT are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

MEANS

[Means for Solving the Problem] Therefore, the multi-cell propagation environmental mimicking device by this invention has two or more attenuators and the control unit which controls the magnitude of attenuation of this attenuator, and this control unit sets up beforehand the orientation pattern of the imagination location of one set of a mobile station, and two or more base stations, and the sector antenna of each base station, and controls the magnitude of attenuation of an attenuator to carry out false [of the propagation loss of two or more propagation paths between a mobile station and a base station]. Thereby, actuation and the engine performance of the mobile station under two or more sets ground office (multi-cell and multisector cel) environment can be evaluated.
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[0009] According to other operation gestalten of this invention, a control unit moves said mobile station to the base station location set up and the orientation pattern of the sector antenna of each base station, and a propagation path parameter list virtually with the passage of time based on mobile station moving trucking and passing speed, calculates said propagation loss which changes with migration of this mobile station, and controls two or more external attenuators serially according to this propagation loss.
[0010] According to other operation gestalten of this invention, the going-up link of mobile station transmission and base station reception, and base station transmission and mobile station reception get down, and a control unit controls a link independently. Thereby, it gets down with an uphill link and the difference in the propagation property of a link can be reflected.
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[0019] First, functional actuation of a base station 1 − n shadowing generation section 23 is explained. For example, it has the generating method which generates a random number and is made into shadowing. [the method of generating shadowing] This operation gestalt explains below how to generate the random number (normal random number) which follows normal distribution as a random number, for example, and generate shadowing from the normal random number.
[0020] The parameter converter 24 manages the parameter set up from the parameter setup section 21, and asks for another parameter required for subsequent processing. the parameter set up -- a logarithm -- the normal random number standard deviation st and a logarithm -- they are the normal random number average value av, the average building width of face W, the moving-average width of face Nw, the mobile station passing speed V0, the mobile station transit time T1, a correlation coefficient rho, and a sampling frequency Fs. From these parameters, shadowing mean wave period deltaTf and the normal random number number N1 are called for. deltaTf=W/V0 N1=T1/deltaTf[0021] the random-number generation section 25 according to log normal distribution -- a logarithm -- the normal random number standard deviation st and a logarithm -- a logarithm carries out group (N3+alpha) generation of the one random number (logarithm normal random number) N according to normal distribution using the normal random number average av. N3 differs according to the number of propagation paths to control. For example, it can express also like N3=N4xN5 from N4 base stations which carry out N control, and N5 propagation paths which around one base station controls. For example, it link [uphill]/Gets down and N5 changes with the number of propagation paths of a link, and independence/common control of a rise-and-fall link. alpha changes with the combination of the number of propagation paths which searches for correlation. For example, alpha= 1 can also be used when searching for correlation between N4=n, N5=1, and an n-tuple (=n base station).
[0022] the logarithm generated for each class -- the normal random number is considered to be data generated for every shadowing mean wave period deltaTf.
[0023] the time amount sampling section 27 -- the logarithm for those each class -- the one normal random number N is sampled with sampling periods delta1/Fs, and the data of two N are generated. The data of all the grouping of an N3+alpha group are sampled.
[0024] The correlation processing section 26 generates the data of 3 sets (it consists of two N for each class) of N by the correlation operation from data [finishing / the sampling of a group (N3+alpha)]. For example, in the case of N4=n, N5=1, and alpha= 1, it is N3=n and the correlation

operation for an n-tuple can also be performed as follows to the group number i= 1 to n+1 (=N3+alpha), the data number j= 1 for every group - N2. The shadowing data [i, j] for [i set] (base station i) Shadowing data [i= 1, j] = data [i=n +1, j] sampled [sqrt(rho) x] + sqrt (1-rho) i= 1 and the sampled [x] [data j] shadowing data [i= 2, j] Data sampled [= sqrt(rho) x] [i=n +1, j] Data sampled [+sqrt(1-rho) x] [i= 2, j] : Shadowing data [i=n, j] Data sampled [= sqrt(rho) x] [i=n +1, j] +sqrt(1-rho) x sampling ending [i=n and Data j] [0025] The moving-average section 28 asks for the moving average of the processing result of the correlation processing section for each class. An example of how to ask for the moving-average data [i, j] for [i set] (base station i) is shown as follows.

$$\text{移動平均ﾃﾞｰﾀ}[i=1, j]=\left(\sum^{Nw-1}\text{ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ}[i=1, j]\right)\div Nw$$

$$\text{移動平均ﾃﾞｰﾀ}[i=2, j]=\left(\sum^{Nw-1}\text{ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ}[i=2, j]\right)\div Nw$$

:

$$\text{移動平均ﾃﾞｰﾀ}[i=n, j]=\left(\sum^{Nw-1}\text{ｼｬﾄﾞｰｲﾝｸﾞﾃﾞｰﾀ}[i=n, j]\right)\div Nw$$

[0026] Next, functional actuation of a base station 1 - n distance fluctuation generation section 29 is explained below. And it can be expressed with Function f (parameter). [the method of generating distance fluctuation] This parameter is a frequency, base station height, mobile station height, the distance between mobile station base stations, etc. This example shows as follows the example which set function f() to f(distance between mobile station base stations) =Ax10, andlog10(distance between mobile station base stations) +B, for example.
[0027] The parameter converter 30 manages the parameter set up from the parameter setup section 21, and changes it into another parameter required for subsequent processing. The parameters set up are a base station coordinate, a mobile station transit course (an initial position, the last location, passing speed, migration coordinate), and Parameters A and B. In addition, the parameter to be used diverts the conversion result of the parameter converter 24.
[0028] Parameters A and B are computed from a distance fluctuation generation type. In this invention, Parameters A and B may be computed by setting up Parameters A and B directly from the parameter setup section 21, inputting a parameter required for a distance fluctuation type from the parameter setup section, and calculating a distance fluctuation type within the parameter converter 30.
[0029] A mobile station travel speed and the transit course processing section 31 ask for the transit course of a mobile station. From the initial position of a mobile station, the last location, and passing speed, the straight-line migration course and circle migration course of a mobile station may be assumed, you may ask for the mobile station location for every time of day, and the coordinate data which stored the mobile station coordinate for every time of day may be directly set up from the parameter setup section 21.
[0030] The distance count section 32 between a mobile station - base stations finds two N per one base station at a time the mobile station for every time of day, and the distance between base stations from the mobile station coordinate for every time intervals delta1/FS, and the base station spacer label of four N.
[0031] The distance fluctuation generation section 33 asks for every time of day and the distance fluctuation for every base station using Parameters A and B. The i-th (for base station i) set of distance fluctuation data [i, j] are called for as follows.
Distance fluctuation [Data [i= 1 and] j] =Axlog10(the j-th of a mobile station and the distance between base stations 1)+B distance fluctuation [Data [i= 2 and] j] =Axlog10(the j-th of a mobile station and the distance between base stations 2)+B: Distance fluctuation [i=n and Data j] =Axlog10(the j-th of mobile station and distance between base stations n)+B [0032] Next, functional actuation of a base station 1 - n propagation loss generation section 34 is explained below.
[0033] Shadowing data and distance fluctuation data are added and propagation loss data are

generated. The i-th (for base station i) set of propagation loss data [i, j] are called for as follows.

propagation loss data [i= 1, j] = i= 1 and the i= 1 and moving-average [data j] + distance fluctuation [data j] propagation loss data [i= 2, j] = i= 2 and i= 2 and moving-average [data j] + distance fluctuation [data j]:propagation loss data [i=n, j] = [moving-average [i=n and Data j] + distance fluctuation data -- i=n, j [0034]] The directional characteristics of antenna gain are added to propagation loss data, and control data is generated. The i-th (for base station i) set of control data [i, j] are called for as follows.
Control data [i= 1, j] = f1 (propagation loss data [i= 1, j], theta 1) control data [i= 2, j] = f2 (propagation-loss data [i= 2, j], theta 2): Control data [i=n, j] = fn (propagation loss data [i=n, j], thetan) [0035] f1-fn are the functions of the directivity response pattern of antenna gain respectively, and theta 1 - thetan are include angles which the straight line which connects a base station and a mobile station to the direction of a core of the directional characteristics of antenna gain makes.
[0036] Next, functional actuation of the attenuator control section 35 is explained below.
[0037] Shadowing data and distance fluctuation data are added and the control signal which controls an attenuator is generated from the control data with which the antenna gain directivity response pattern was considered.
[0038] For example, if it is the attenuator (the magnitude of attenuation changes according to the electrical potential difference to apply) by which armature-voltage control is carried out, control data will be set by the control voltage pair magnitude-of-attenuation property of an attenuator, and it will change into an analog voltage signal.
[0039] For example, if it is a 60dB attenuator at 0dB of magnitude of attenuation, and 10 V:00, D/A conversion is performed, 0dB data will be changed into 0V, and 60dB data will be changed into the analog voltage of 10V at electrical-potential-difference 0 V:00.
[0040] For example, in the case of the attenuator controlled using an analog current, control data is converted into an analog current signal according to a control current pair magnitude-of-attenuation property.
[0041] For example, in the case of the attenuator controlled using a digital signal, control data is converted into a digital control signal according to a digital control signal pair magnitude-of-attenuation property.
[0042] The magnitude-of-attenuation range of control data amends, when it is over 1n 1-1n of control ranges of 4, attenuators 111-114 and. For example, when the control data is changing in 90dB - 150dB, control data is stored in attenuators 111-114 and the control range of 1n1-1n4 by dividing this into 90dB + adjustable 60dB), and making only a part for adjustable into the controlled system of a control device 2. [of (fixed parts] [per part] In this case, it sets up with the fixed attenuator which prepares 90dB of fixed parts separately, and only a part for adjustable [of 0-60dB] is changed into control signals, such as an analog voltage signal, an analog current signal, and a digital control signal.
[0043] The changed control signal is sent to attenuators 111-114 and 1n1-1n4 via the attenuator control signal line 36, and control is performed.
[0044] Thus, it was what creates control data collectively with the operation gestalt mentioned above before initiation of control.
[0045] On the other hand, it has [mounting which takes the format of Real Time Control data generation -> control activation of carrying out the concurrency of the creation of control data to activation of control, and performing it as other operation gestalten] any problem and is possible. In this case, although the data of previous time of day are needed from the time of day at the control event at the time of moving-average processing, it can be coped with by foreseeing and preceding it and creating data.
[0046] Next, change of the continuous magnitude of attenuation which does not break off as other operation gestalten by using PIN diode continuation variable attenuator for the attenuator of a controlled system is possible.
[0047] If the common step attenuator which does not use a PIN diode is used, since it may be set as the value (example: it will converge on the magnitude of attenuation as a control signal if

the magnitude of attenuation becomes max momentarily and time amount passes for a while whenever the magnitude of a control signal changes) which the magnitude of attenuation does not expect momentarily for every change of the amount of control signals, it is not suitable for assessment of the land-mobile communication link using a CDMA method.
[0048] Next, the sector cel in a land-mobile communication link is realizable as other operation gestalten by using a directive antenna pattern for the directivity response pattern of antenna gain. A sector cel is the technique of dividing one cel into two or more fields called a sector, preparing the antenna of dedication for every sector, and covering a cel.
[0049] For example, the cel in which directivity shifts and arranges the directional antenna which is 120 degrees every 120 degrees is called 3 sector cel. This invention can realize 3 sector cel by setting three base stations which make a base station position coordinate the same as a control unit 2, shifting the directivity response pattern of the antenna gain of each base station by a unit of 120 degrees, and setting it as a control unit 2. If it does in this way, sector cels other than 3 sector cel can also be simulated like 6 sector cel and 12 sector cel.
[0050] Drawing 2 is the block diagram of the land-mobile communication link measurement environment of three base stations constituted using the multi-cell propagation environmental mimicking device by this invention, and one mobile station. This drawing 2 is simulating the land-mobile propagation environment by combining this invention with the phasing simulator which simulates instant fluctuation.
[0051] In the land-mobile communication link measurement environment of drawing 2 , 61 and the mobile station transmitting antenna edge 62 which are 39 which is the base station 1 transmitting antenna edge 37, the base station n transmitting antenna edge 38, and the base station 1 receiving-antenna edges 1 and 2, 40 which is the base station n receiving-antenna edges 1 and 2, the phasing simulator 5, a distributor 41, the synthetic vessel 42, the fixed attenuator 43 for control range amendment, and the mobile station receiving-antenna edges 1 and 2 are included. This fixed attenuator 43 for control range amendment is a fixed attenuator for control range amendment explained in functional actuation of the attenuator control section 35.
[0052] Drawing 3 is the block diagram of the land-mobile communication link measurement environment which added the function which controls the phasing simulator 5 of drawing 2 to the control unit 2. The control signal line 36 also transmits the signal for control of a phasing simulator.
[0053] The parameters common to the parameter which the phasing simulator 5 uses, and the parameter which this invention uses are mobile station passing speed and parameters required for the formula of Parameters A and B, and they are collectively set up from a control unit 2.
[0054] In the base station 1 mentioned above - n shadowing generation section 23, all the sampled data of the group (N3+alpha) after time amount sampling section 27 processing synchronize, and a value changes. The propagation environment more near reality is reproducible by changing this and changing the timing from which a value changes for each class.
[0055] Shifting the timing from which a value changes in the group unit for each class generates the uniform random number Ri (i=1-N3+ range 0-1 of alpha and Ri) of a group (N3+alpha), and it is Si =. In case it asks for a Rixdelta TfxFs sampling (sampling frequency Fs) and calculates in the correlation processing section 26, it is possible by calculating by shifting Si sampling timing every for each class. That is, the shadowing data after the i-th set of correlation processings [i, j] are called for as follows.
shadowing data [i= 1, j+S1] = sqrt (rho) data [i=n +1, j+Sn +1] sampled [x] i= 1 and sampled [+sqrt(1-rho) x] data [j+S1] shadowing data [i= 2, j+S2] Data [i=n +1, j+Sn +1] sampled [= sqrt (rho) x] + sqrt Data sampled [x] [i= 2, j+S2] : (1-rho) Shadowing data [i=n, j+Sn] = data sampled [sqrt(rho) x] [i=n +1, j+Sn +1] +sqrt(1-rho) x sampling ending data [i=n, j+Sn] [0056] In case it shifts to different timing part back for each class, it devises putting 0 into the data to have shifted uniformly etc.
[0057] the timing from which a value changes -- a logarithm -- making it change at random per normal random number -- for example Generate the uniform random numbers Ri and j (i=1-N3+alpha, j=1- range of N1 and Ri - 0.5-0.5) of a group, calculate Ti, j = Ri, and jxdelta TfxFs,

and the sampled data of a group (N3+alpha) are received. (N3+alpha) It is possible by Ti and shifting j sampling timing every in the timing from which data change.

[0058] the timing from which a value changes -- every group -- changing -- further -- a logarithm -- in order to make it change at random per normal random number, if the above-mentioned two kinds within this operation gestalt of processings are combined and are performed, it will realize.

[0059] As mentioned above, according to this contractor, in the operation gestalt explained to the detail, various modification, corrections, and abbreviations in within the limits of the technical thought of this invention and a standpoint can be performed easily. Therefore, the operation gestalt mentioned above is an example to the last, and it is not going to restrain it at all. This invention is restrained by only what is limited as a claim and its equal object.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the basic block diagram of the multi-cell propagation environmental mimicking device of this invention.
[Drawing 2] It is the block diagram of the land-mobile communication link measurement environment of three base stations constituted using the multi-cell propagation environmental mimicking device by this invention, and one mobile station.
[Drawing 3] It is the block diagram of the land-mobile communication link measurement environment which added the function which controls the phasing simulator 5 of drawing 2 to the control unit 2.
[Description of Notations]
111 Attenuator 1 for Base Station 1 Going-Up Link
112 Attenuator 2 for Base Station 1 Going-Up Link
113 Get Down Base Station 1 and it is Attenuator 1 for Link.
114 Get Down Base Station 1 and it is Attenuator 2 for Link.
1n1 Attenuator 1 for a base station n going-up link
1n2 Attenuator 2 for a base station n going-up link
1n3 It base-station n Gets down and is the attenuator 1 for a link.
1n4 It base-station n Gets down and is the attenuator 2 for a link.
2 Control Unit
21 Parameter Setup Section
22 Control Section
23 Base Station 1 - N Shadowing Generation Section
24 Parameter Converter
25 Random-Number Generation Section according to Log Normal Distribution
26 Correlation Processing Section
27 Time Amount Sampling Section
28 Shadowing Strange Cadre
29 Base Station 1 - N Distance Fluctuation Generation Section
30 Parameter Converter
31 Mobile Station Travel Speed and Transit Course Processing Section
32 Distance Count Section between Mobile Station - Base Stations
33 Distance Fluctuation Generation Section
34 Base Station 1 - N Propagation Loss Generation Section (Shadowing + Distance Fluctuation + Antenna Directivity)
35 Attenuator Control Section
36 Attenuator Control Line
37 Base Station 1 Transmitting Antenna Edge
38 Base Station N Transmitting Antenna Edge
39 Base Station 1 Receiving-Antenna Edges 1 and 2
40 Base Station N Denary Antenna Edges 1 and 2
41 Distributor

42 Synthetic Vessel
43 Fixed Attenuator for Control Range Amendment
5 Phasing Simulator
61 Mobile Station Receiving-Antenna Edges 1 and 2
62 Mobile Station Reception Transmitting Antenna Edge

[Translation done.]